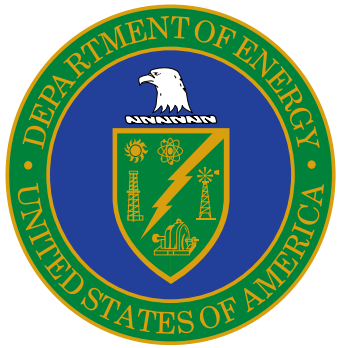


Accelerated Strategic Computing Initiative
--
alliance pre-proposal conference

December 5-6

Gil Weigand

Deputy Assistant Secretary for
Strategic Computing and Simulation

U.S. Department of Energy

President Clinton's Vision:

"...we can meet the challenge of maintaining our nuclear deterrent under a [comprehensive test ban] through a stockpile stewardship program without nuclear testing."

ASCI Vision

Create leading-edge computational modeling and simulation capabilities critically needed to

promptly shift from nuclear test-based methods to computational-based methods,

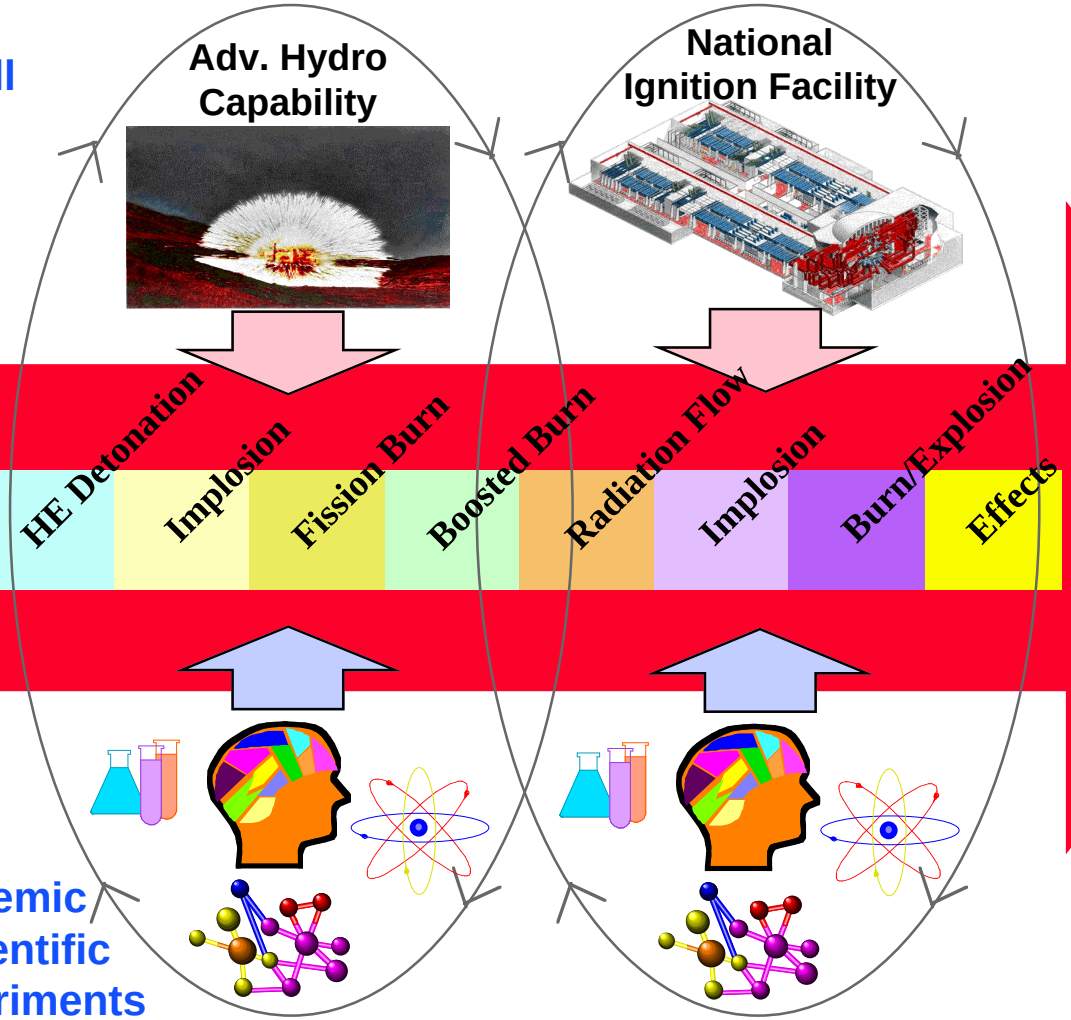
to integrate stockpile stewardship elements and provide an integrated nuclear explosion testbed.

Simulation Tools Provides Integration of Great Science, Experimental Facilities and Archive Data for Confidence in the Stockpile

① **Full scale or full energy-density studies & experiments**

② **Computation & Modeling**

③ **World-class & forefront, academic & lab scale scientific studies & experiments**



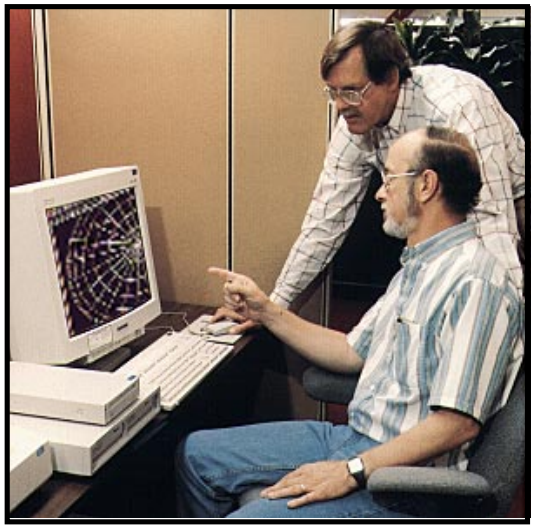
Confidence in

- **Safety**
- **Reliability**
- **Performance**

We are focused on Nuclear Weapons Simulation

Simulation

"digital proxy for physical"



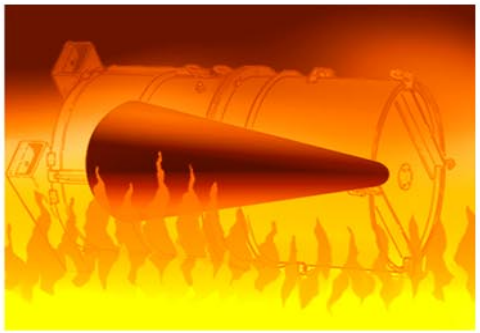
National Labs / applications, weapon science, simulation & AGEX, adv. computation

Computer Co's / computers, software & OS, prog. support

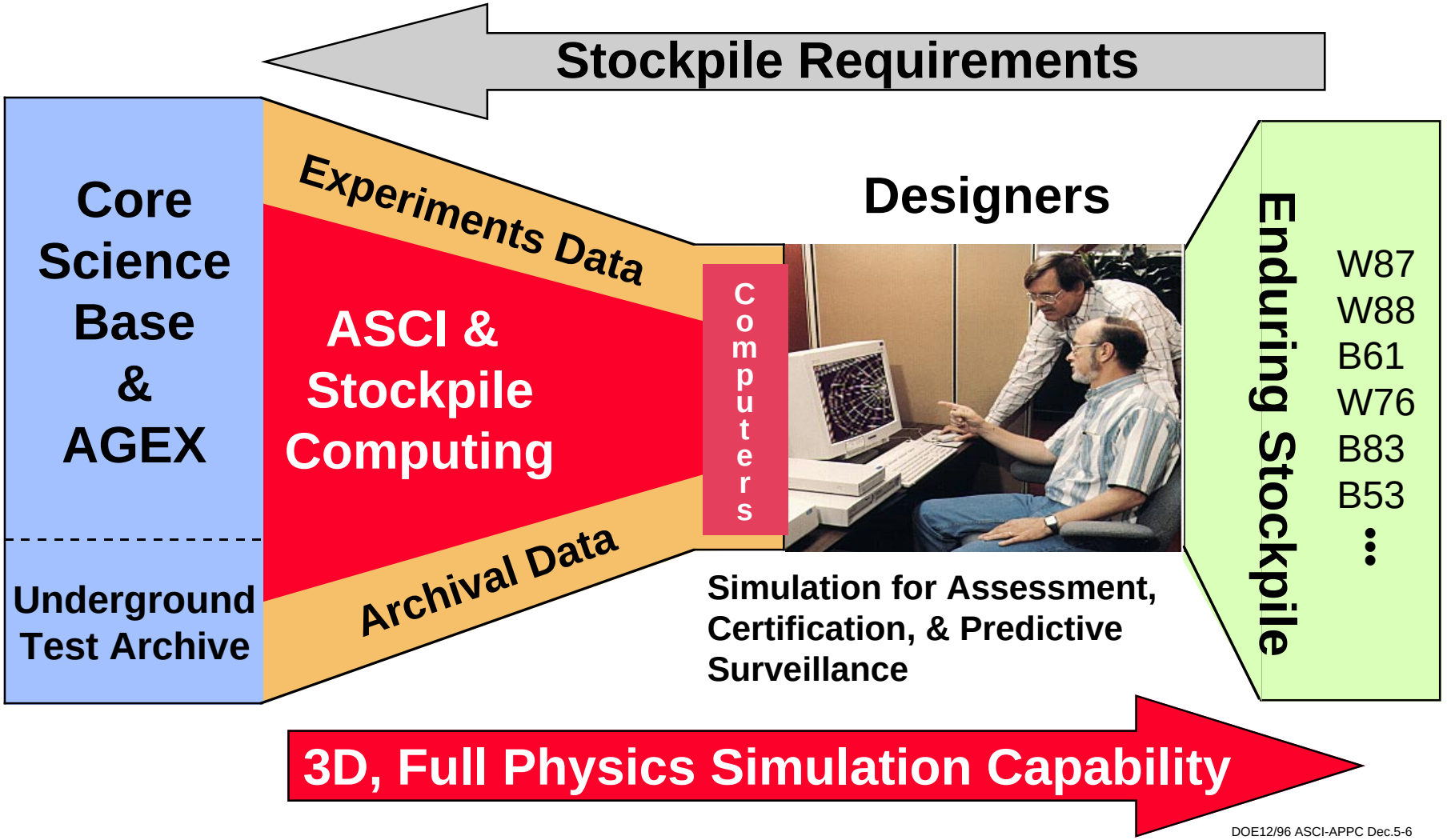
University & other Lab / science collaboration, applications & prog. tools

The Mechanics of Crash & Burn for Non-Nuclear Safety

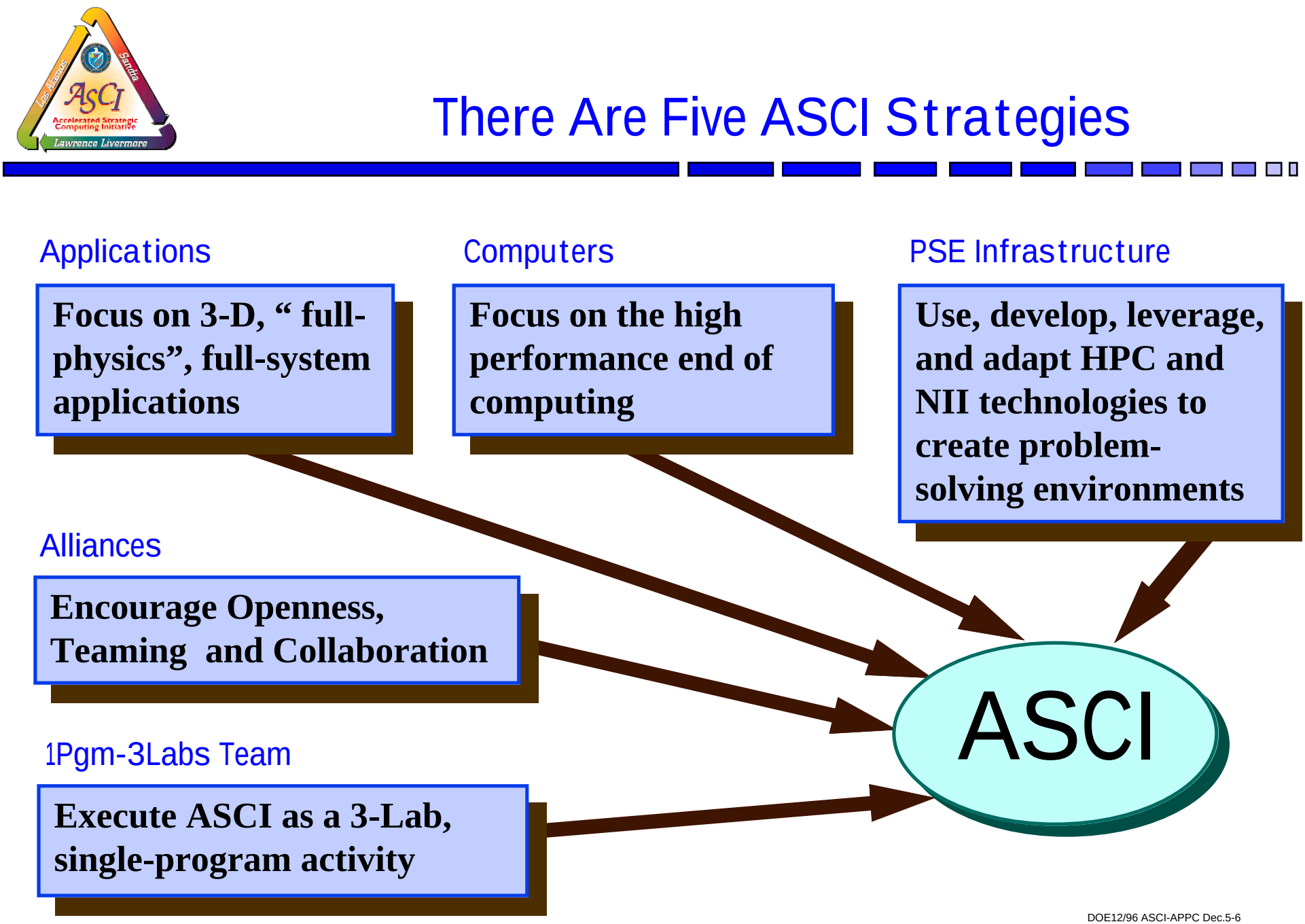
- Structural Impact
- Fuel Dispersal
- Fire Dynamics
- Thermal Insult
- Chemical Decomposition
- Pressurization
- Fracture
- Gas Expansion
- Electrical Insult



ASCI produces and supports simulation capabilities for designers who make critical decisions about the enduring stockpile



There Are Five ASCI Strategies



Applications focus on 3D, "full-physics", high fidelity simulation, have key milestones tied to the stockpile, and require unprecedented application and computer speed increases

96 97 98 99 00 01 02

"Full-physics initial operating capability"

Component-deterioration model

Full-physics prototype

3D Forging/welding micro-structure

Crash/fire safety

Macro/micro aging

Prototype 3D physics

3D Casting microstructure

High-fidelity safety calculation

Micro aging

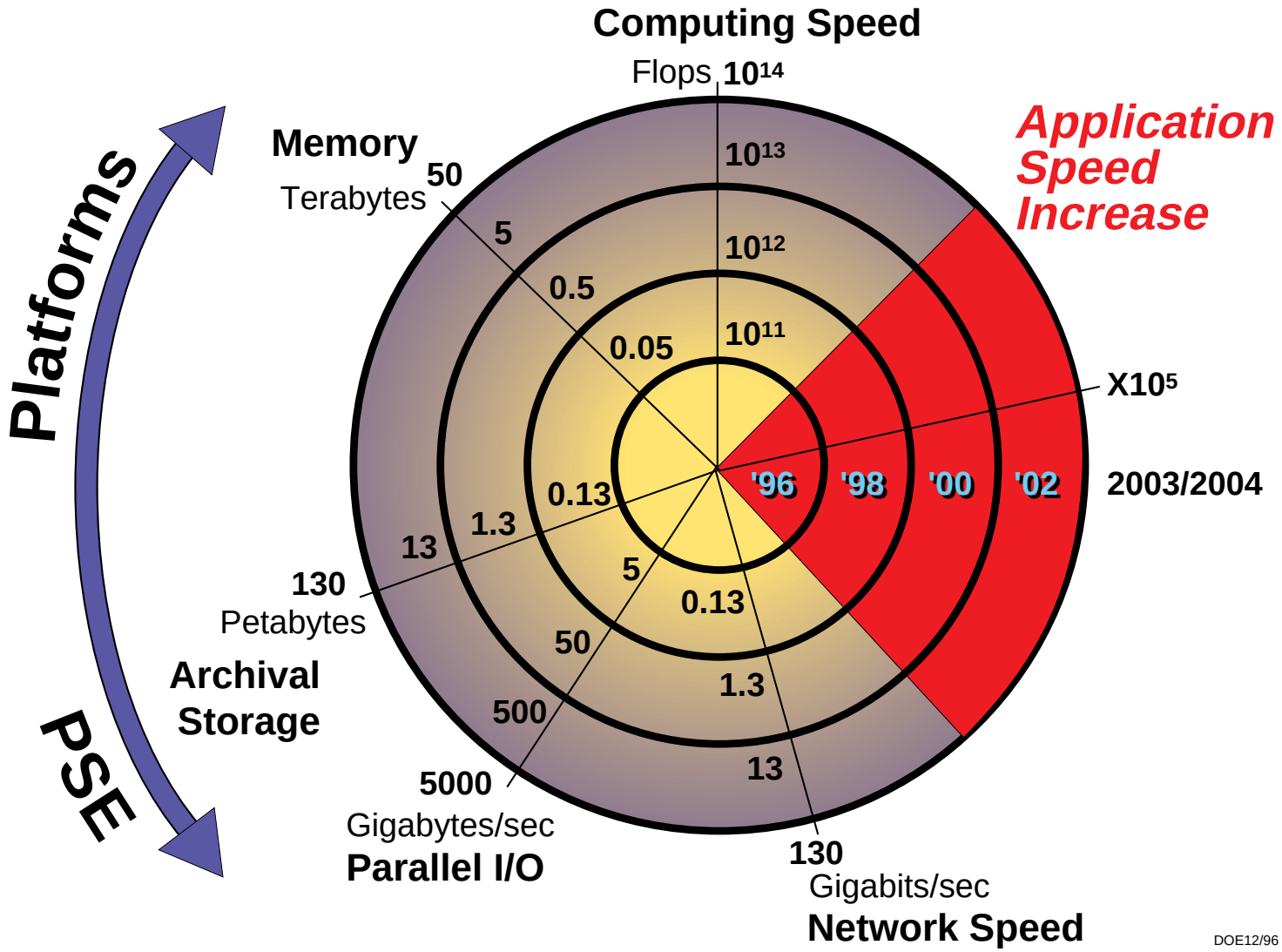
Legend:

Virtual testing

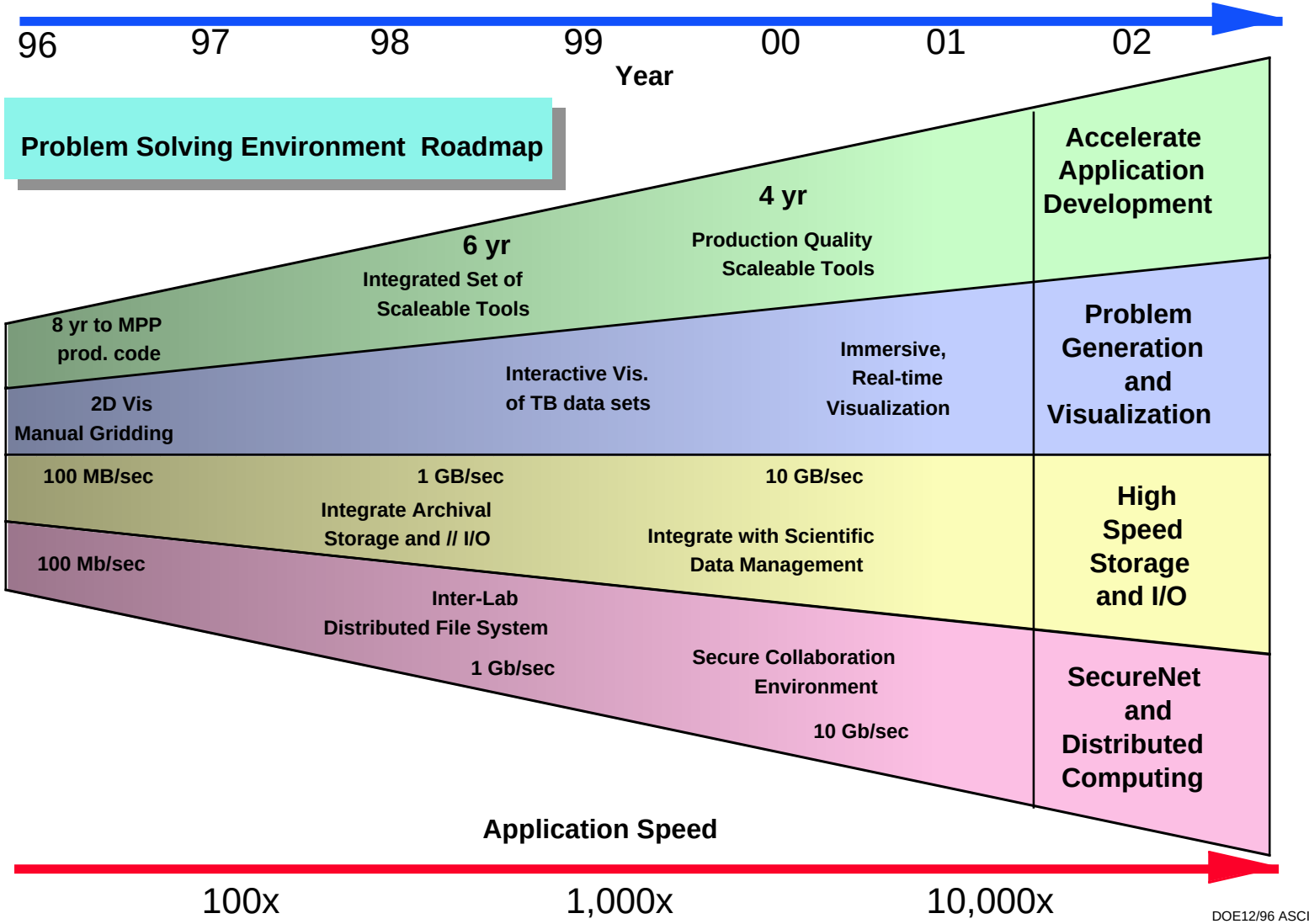
Virtual prototyping

needed application speed gain--> 100 X 1000 X 10000 X … 100000 X

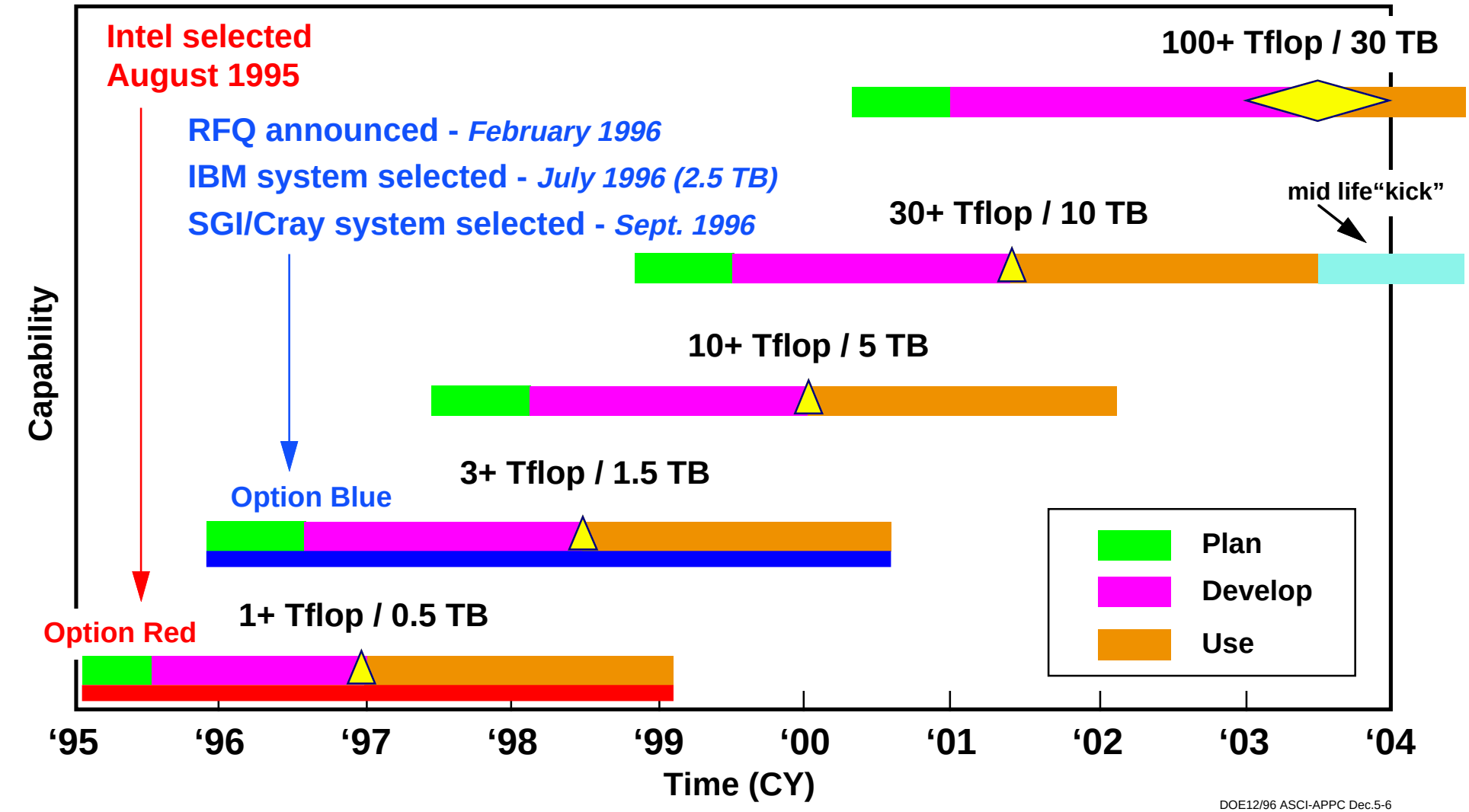
ASCI Success Depends upon Balanced Growth across all Strategies



Problem Solving Environment Roadmap



ASCI Computing Systems Roadmap
-- working with industry to reach unprecedented computer performance --



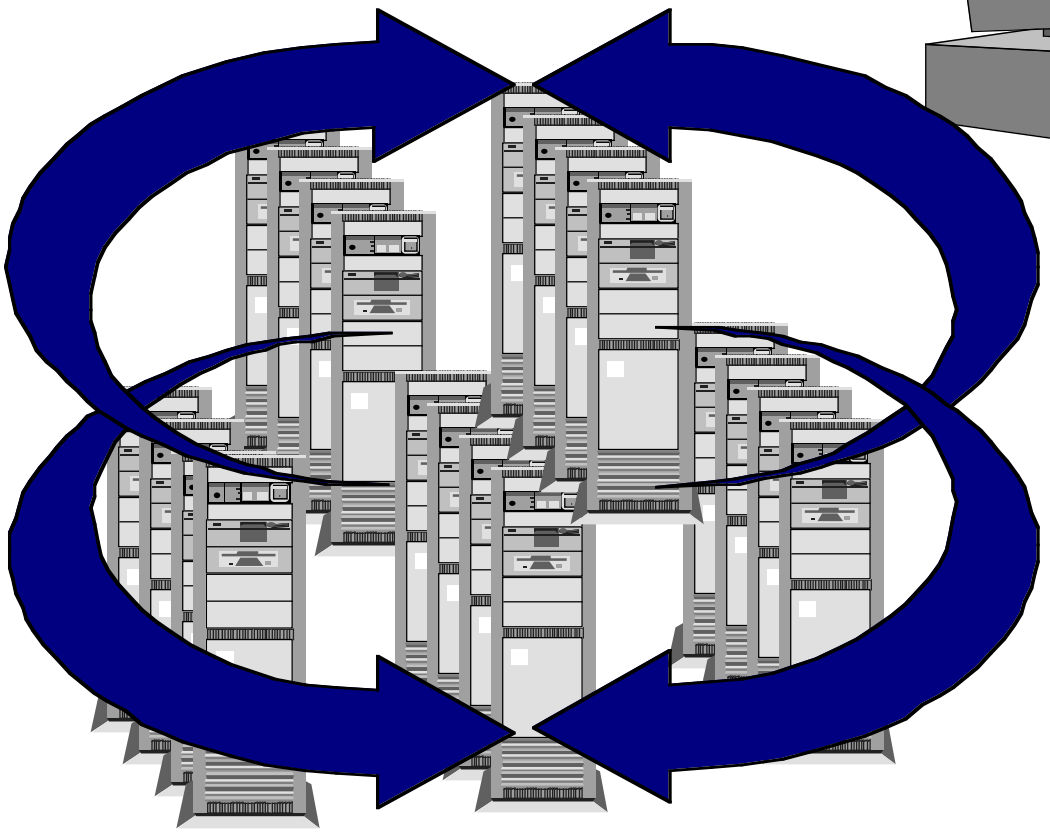
Option Red - General System Characteristics

- 4536 Two Processor Nodes – 9072 P6 200 MHz Processors
- 64 MBytes per Node
- OS Capability to treat two nodes as one node with 128 MBytes
- 2.42 TBytes/sec Aggregate Memory Bandwidth
- 1.0 GBytes/sec Aggregate Disk System I/O Bandwidth
- 38 x 32 x 4 Communication Logical Mesh Size (Topology)
- 800 MBytes/sec Bi-Directional B/W per Link
- 51.2 GBytes/sec Bi-Directional Cross Section B/W
- 32 Service Nodes
- Ethernet, FDDI, ATM (OC-12)
- Full Unix (OSF/1) Running on the Service Nodes
- Light Weight Kernel (LWK) Running on Compute Nodes (Puma Based)

ASCI-Blue:

A single system composed of commercial multiprocessor computers linked with a high speed interconnect.

3 Peak Teraflops
1.5 Terabytes Memory
75 Terabytes Disk



- **A single system allows both parallel and serial software to be used**
- **A single system view reduces operational complexity**

IBM Approach: Large Number of Nodes then SMP

IBM SP-3

- 3.23 TF Peak + 0.855 sPPM TF Sustained
- 512 SMPs, 2.5 TB Memory, 76 TB Disk
  - Each SMP 8 way PPC 630 @ 400 MHz (option for 16 way)
  - Each SMP 3 GB Memory
  - UMA Memory Architecture
- Colony Switch and Adapters
  - Baines Network (like Meiko)
  - MPI Delivered Performance
    - 22 microsec latency
    - 850 MB/s bandwidth (1.7GB/s bi-directional)

SGI Approach: Big SMP Node First, then More Nodes

SGI Scaleable Node-1 (SN-1)

- 24 logical SMPs, 1.5 TB Memory, 76 TB Disk
  - Each SMP 128 way H1 microprocessor @ 500 MHz
  - Each SMP 62.5 GB Memory
  - DSM (NUMA) Architecture over 3072 nodes
- Distributed Shared Memory Architecture
  - Cache coherent shared memory over 4096
  - Fat hypercube with multiple 1-D torus connections
  - 5 microsec MPI Delivered Performance

Alliances Strategy

- Motivation
  - ASCI simulation and computing problems are so hard that labs cannot solve them alone
  - Develop a broad consensus that simulation is an appropriate means of ensuring confidence in the safety, performance and reliability of the stockpile
  - Help train the next generation of stockpile stewards
- Three Levels
  - Strategic Alliances
  - Strategic Investigations
  - Task Oriented Collaborations

Academic Strategic Alliance Program (ASAP)
Lawrence Livermore National Laboratory..
Los Alamos National Laboratory.. Sandia National Laboratories
United States Department of Energy, Defense Programs

Major Goals and Objectives

- Establish and validate the practices of large scale modeling, simulation, and computation as a viable scientific methodology in key scientific and engineering applications that support DOE science-based stockpile stewardship goals and objectives.
- Accelerate advances in critical basic sciences, mathematics, and computer science areas, in computational science and engineering, in high performance computing systems and in problem solving environments that support long-term ASCI needs.
- Establish technical coupling of Strategic alliances efforts with ongoing ASCI projects in DOE laboratories.
- Leverage other basic science, high performance computing systems, and problem solving environments research in the academic community.
- Strengthen training and research in areas of interest to ASCI & SBSS and strengthen the ties among LLNL, LANL, SNL and Universities.

Academic Strategic Alliances

- Large, long term relationships to achieve broad milestones
- Support confidence in Simulation
- Multidiscipline, coordinated effort
- 4 - 5 alliances (single institution....collaboration with other key researchers and industry partners are ok)
- $4-$5M/yr each for up 10 years

Examples of Potential Research Topics

- Physical Sciences/Mathematics
  - Hydrodynamics
  - Transport
  - Material Modeling (including aging)
  - Turbulence
  - Numerical Methods
  - Applications & Computer Algorithms
- Computer & Computational Science
  - Petaop Systems &Software
  - Scaleable Architecture
  - Scaleable I/O
  - Visualization
  - Data Management
  - Tools
  - Libraries for Scaleable Systems